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Responsiveness of the anterior cruciate ligament – Return to Sports after Injury (ACL-RSI) and Injury – Psychological Readiness to Return to Sport (I-PRRS) scales

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ABSTRACT

The ACL-Return to Sport after Injury (ACL-RSI) and Injury-Psychological Readiness to Return to Sport (I-PRRS) scales were developed to assess psychological factors associated with return to sports. Validity and reliability have been determined. The aim of this study was to investigate the responsiveness of the Dutch ACL-RSI and I-PRRS. Seventy patients with ACL reconstruction completed both scales twice 2 months apart, plus a Global Rating of Change (GRC) questionnaire. Distribution and logistic regression-based methods were used to study responsiveness. The Standardized Response Mean (SRM) for the ACL-RSI was 0.3 and for the I-PRRS 0.1, indicating low responsiveness. The minimally important change (MIC) for ACL-RSI was 2.6 and for the I-PRRS 0.9. Since the standard error of measurement (SEM) and smallest detectable change (SDC) were larger than MIC in individual patients, it does not seem possible to distinguish minimally important changes from measurement error in individual patients with either scale. At the group level responsiveness seemed sufficient; hence, both scales can be used to investigate the effectiveness of an intervention at the group level. Both scales can also be used in cross-sectional research and in clinical practice as screening instruments to identify patients at risk of not returning to sports.

ARTICLE HISTORY

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KEYWORDS

ACL-RSI; I-PRRS; confidence; return to sport; anterior cruciate ligament reconstruction; responsiveness

Introduction

After anterior cruciate ligament (ACL) injury, especially young and active athletes expect a complete recovery of function with the ability to resume all activities. One of the most important reasons to perform ACL reconstruction (ACLR) surgery is therefore to reduce knee instability in order to facilitate a return to pre-injury physical activity levels (Barber-Westin & Noyes, 2011; Ellman et al., 2015; Feller & Webster, 2013). Postoperative outcomes such as knee stability and muscle strength have been shown to be excellent (Arden, Webster, Taylor, & Feller, 2011b), but participation – particularly in competitive sports – is disappointingly low (Arden, Taylor, Feller, & Webster, 2014). The recovery of physical capabilities alone does not appear to be enough to ensure a successful return to sport (Arden, Webster, Taylor, & Feller, 2011a). Based on several systematic literature reviews it is acknowledged that both physical and psychological readiness are important for a successful sport resumption, that the two do not always coincide, and that negative psychological responses may decrease the likelihood of a successful return to sport (Arden, Taylor, Feller, & Webster, 2013; Brewer, 2010; Forsdyke, Smith, Jones, & Gledhill, 2016; Ivarsson, Tranaeus, Johnson, & Stenling, 2017; Podlog, Heil, & Schulte, 2014).

Questionnaires are available to assess psychological factors associated with sport resumption. Webster, Feller, and Lambros (2008) developed and studied the validity of the ACL Return to

Sports after Injury (ACL-RSI) scale, which was designed to evaluate three psychological responses of athletes in relation to sport resumption following ACL injury and/or surgery: emotions, confidence in performance, and risk appraisal. The ACL-RSI has been translated into several languages and is considered valid and reliable (Bohu, Klouche, Lefevre, Webster, & Herman, 2015; Chen et al., 2017; Harput et al., 2017; Kvist et al., 2013; Silva, Mendes, Lima, & Almeida, 2017; Slagers, Reininga, & van Den Akker-Scheek, 2017). Glazer developed the Injury Psychological Readiness to Return to Sport (I-PRRS) scale to assess the psychological readiness of injured athletes to return to sports participation, irrespectively of the type of injury (Glazer, 2009). Valid and reliable English, Persian and Dutch versions of the I-PRRS scale are available (Naghdi et al., 2016; Slagers, Reininga, Geertzen, Zwerver, & van den Akker-Scheek, 2019).

The responsiveness of the ACL-RSI and I-PRRS scales, however, has not been examined in previous studies. Responsiveness is defined as the ability of a questionnaire to detect clinically important changes over time (Guyatt, Deyo, Charlson, Levine, & Mitchell, 1989; Mokkink et al., 2010; Terwee et al., 2007). Knowledge of what change in score is meaningful to patients may help clinicians to interpret improvement in score. Methods to estimate what change in score can be considered clinically important, can coarsely be divided into two groups: distribution-based and anchor-based methods (de Vet et al., 2006). Distribution-based methods are based on the

statistical characteristics of the sample. Using the distribution-based method the standard error of measurement (SEM) and smallest detectable change (SDC) has determined for the Dutch and Swedish translations of the ACL-RSI and the Dutch translation of the I-PRRS (Kvist et al., 2013; Slagters et al., 2017; Slagters et al., 2019). A major disadvantage of this method is that it does not provide a good indication of the importance of the observed change as perceived by the patient (de Vet et al., 2006). Anchor-based methods use an external criterion to evaluate whether the change in score is perceived as important by the patient. Hence, there is a need to determine the minimally important change (MIC) (Terwee, Roorda, Knol, De Boer, & De Vet, 2009). It is important to consider MIC in relation to the measurement error of a questionnaire. If a measurement error is smaller than MIC, it is possible to distinguish clinically important change from measurement error. For responsive questionnaires, the value above the MIC and SDC is statistically significant, clinically important and can be considered as a “real” change (Terwee et al., 2009).

More information about responsiveness of these questionnaires is needed to determine whether the questionnaires are suitable to monitor the progress of individual patients, evaluate the effectiveness of individual/group interventions, and judge whether a patient has reached a change of clinical importance. The aim of this study was therefore to investigate the responsiveness of the Dutch ACL-RSI and I-PRRS scales.

Methods

Participants

Patients who had undergone an ACLR between 1 October 2012 and 1 August 2013 at the Orthopaedic Department of Martini Hospital Groningen or at the Departments of Orthopaedics or Trauma Surgery of University Medical Center Groningen were recruited. Patients were eligible for participation if they had undergone ACL reconstruction 3–9 months previous to the start of the study and participated in sports activities before the ACL injury. This specific time interval was chosen because the greatest change in psychological factors regarding return to sport is to be expected in this rehabilitation phase, as patients perform sport-specific exercises and start to focus on return-to-sports activities (van Melick et al., 2016). Non-athletes and patients with a revision ACLR were excluded, as were patients unable to understand written Dutch. The local Medical Ethical Committee judged the procedures employed in this study and waived further need for approval (METC 2013–50).

Procedure

Eligible patients received the Dutch versions of the ACL-RSI scale, I-PRRS scale (Slagters et al., 2017; Slagters et al., 2019), and an accompanying information letter by mail. To measure the current level of sports activities, patients were asked to complete the Tegner Activity Score as well (Tegner & Lysholm, 1985). Patients were asked to fill in the questionnaires at

home and return them by mail. Patients who did not respond after 1 week were reminded once by mail.

Demographic characteristics (gender, height, weight, age and surgery date) were retrieved from electronic patient records. After 2 months, responders of the first mailing were asked to complete the ACL-RSI and I-PRRS scales for the second time, together with a Global Rating of Change question.

Questionnaires

The ACL Return to Sports after Injury (ACL-RSI) scale consists of 12 questions about the psychological impact of returning to sports in this population (Webster et al., 2008). It was developed in relation to three elements that have been correlated with returning to sports in the literature: emotions, confidence in one's performance, and evaluation of risk. Each question is scored with an 11-point numeric rating scale in the form of boxes to be ticked from 0 to 100. A total score is calculated by summing the responses on each question and transforming the score so that the range is from 0 to 100. A high score is indicative of a positive psychological response. ACL-RSI has shown to be valid and reliable (Slagters et al., 2017). This research showed that SDC is 15.3 for individuals and 1.5 for groups, and the SEM is 5.5.

The Injury Psychological Readiness to Return to Sport (I-PRRS) scale was developed to assess the psychological readiness of injured athletes to return to sport (Glazer, 2009). The I-PRRS scale consists of six items that are scored on a 100-point scale. The scores from the six items are summed and divided by 10 to calculate the I-PRRS total score. A score of 60 indicates high confidence in return to sports, 40 moderate confidence and 20 low confidence. I-PRRS has shown to be valid and reliable (Slagters et al., 2019). This research showed that SDC is 11.6 for individuals and 1.1 for groups, and the SEM is 4.2.

The Tegner Activity Score (TAS) is designed to evaluate individuals with knee injury and their level of activity based on specific sports participation and/or line of work (Tegner & Lysholm, 1985). The TAS ranges from 0 (sick leave or disability due to knee problems) to 10 (participation in competitive sports at a national or international level). Scores of 5–10 can only be achieved if the patient participates in recreational or competitive sports. The higher the score, the higher the level of activity. Patients were asked to score the activity level before the injury (retrospectively), the current level of activity and the desired level of activity. The TAS is found valid and reliable for assessing activity level in individuals with an ACL injury (Eshuis, Lentjes, Tegner, Wolterbeek, & Veen, 2016).

A Global Rating of Change (GRC) score, which is a single-item questionnaire to quantify a change in a certain construct over a specified period of time, was used as an external criterion to assess whether participants had improved, deteriorated or not changed (Kamper, Maher, & Mackay, 2009). For the current study, participants were asked if they perceived a change in confidence regarding sports resumption over the last two months (between the first and second administration of the questionnaires). The GRC was scored on a 5-point Likert scale ranging from +2 (“much more confident”) through 0 (“about the same”) to –2 (“much less

confident"). As proposed by (de Vet et al., 2007; Terluin, Eekhout, Terwee, & de Vet, 2015; Terwee et al., 2009), patients were dichotomised into two categories based on their answer on the GRC question: patients who reported being "more confident" and "much more confident" were considered importantly improved; those who reported having "about the same" confidence were considered unchanged. Patients who reported having "(much) less confidence" were left out of the responsiveness analysis.

Statistical analyses

Descriptive statistics were used for patient characteristics and to display outcomes of questionnaires. Responsiveness was studied using both the distribution-based method and the logistic regression-based method of Terluin et al. (2015).

The distribution-based method was used to compare the results of the two ACL-RSI and I-PRRS measurements and to examine whether there was a statistically significant change in scores between the two measurements. The Standardized Response Mean (SRM) was calculated, which is the ratio of the mean change between baseline and follow-up assessment to the SD of the mean (Norman, Wyrwich, & Patrick, 2007). SRM values of <0.5 are considered to indicate low responsiveness, a SRM 0.5–0.8 moderate and >0.8 large responsiveness (de Vet et al., 2007, 2006). The SDC and SEM were retrieved from the reliability and validity studies (Slagers et al., 2017; Slagers et al., 2019).

With the logistic regression-based method, the dichotomised GRC score was used as the external criterion for confidence in sport resumption to evaluate whether the change in score was perceived as important by the patient and to determine MIC. Univariate logistic regression analyses were performed for both the ACL-RSI and I-PRRS scales. The outcome variable was the dichotomised GRC score ("much more confident" and "about the same confidence"). The predictor variable was the change in ACL-RSI or I-PRRS score between the two measurements. The MIC values with corresponding 95% confidence intervals were calculated. We refer to the original work of Terluin et al. (2015) for more detailed information about this method. The diagnostic performance of the GRC was also evaluated by calculating sensitivity, specificity, positive predicted value, negative predicted value and percentage of misclassification. All statistical analyses were performed using IBM SPSS software, version 23.0 for Windows (IBM Corporation, Armonk, NY). A *p*-value of <0.05 was considered statistically significant.

Results

Participants

Of the 143 patients who were considered for this study, 28 were excluded for various reasons (patients with a revision ACLR *n* = 24, non-athletes *n* = 2, unable to understand written Dutch *n* = 2). In total, 115 patients were sent the questionnaires in the first mailing and 82 completed them (response rate 71%). Seventy responders completed the questionnaires for a second time after 2 months (response rate 85%).

Table 1. Demographic characteristics of the participants.

Characteristics	Participants* (<i>n</i> = 70)
Age on ACLR date (years)	27.5 (10.2)
Gender	
Male	43 (61%)
Female	27 (39%)
Height (cm)	178 (10)
Body weight (kg)	77 (17)
BMI (kg/m ²)	24.1 (3.6)
Graft type	
Semitendinosus/Gracilis (%)	67 (96%)
Bone-tendon-bone (%)	3 (4%)
Time after surgery	5 (1.6)
Tegner activity level score	
activity level before ACLR	7.8 (1.6)
activity level at start of study	5.1 (1.7)
desired activity level	7.7 (1.6)

* Presented as mean (SD) unless percentages are indicated.

Demographic characteristics of the participants who responded to both mailings are shown in Table 1. Over half of them participated mainly in soccer (*n* = 38; 54%). The main sports of the other participants were distributed between all kinds of pivoting, contact and non-contact sports (see Appendix Table A1).

Outcomes

Mean time between the first and second measurement was 80 (SD 19.3) days. In this time period, the mean ACL-RSI and I-PRRS scores increased for the total group (Table 2). Based on the GRC score, 47 patients (67%) had (much) more confidence, 15 (21%) reported no change, and 8 patients (12%) had (much) less confidence. The SRM for the ACL-RSI scale is 0.3 and for the I-PRRS scale 0.1, respectively.

Minimal important change

ACL-RSI

Mean change in ACL-RSI score in the subgroup of patients that reported having more confidence in the GRC after the second administration was 8.6 (SD = 12.5). Mean change in the subgroup of patients that reported being "about the same" was −3.1 (SD = 17.8). MIC was 2.6 points, with a misclassification rate of 37% (Table 3).

I-PRRS

Mean change in I-PRRS score in the subgroup of patients that reported having more confidence in the GRC after the second administration was 7.0 (SD = 12.0). Mean change in the subgroup of patients that reported being "about the same" was

Table 2. Descriptive statistics, SRM, SEM and SDC values of the ACL-RSI and I-PRRS.

	Mean (SD) <i>t</i> ₁	Mean (SD) <i>t</i> ₂	Mean (SD) <i>t</i> ₂ − <i>t</i> ₁	SRM	SEM	SDC _{ind}	SDC _{group}
ACL-RSI	55.8 (21.6)	60.1 (22.5)	4.3 (14.8)	0.3	5.5	15	1.5
I-PRRS	68.2 (21.6)	69.5 (20.2)	1.3 (15.6)	0.1	4.2	11.6	1.1

Abbreviations: *t*₁: first administration; *t*₂: second administration; SD: standard deviation; SRM: standardised response mean; SEM: standard error of measurement; SDC_{ind}: smallest detectable change for individuals; SDC_{group}: smallest detectable change for groups; ACL-RSI: anterior cruciate ligament – return to sports after injury; I-PRRS: injury psychological readiness to return to sport.

Table 3. Minimal important change scores for improvement of ACL-RSI and I-PRRS.

	MIC	95% CI	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	% MIS
ACL-RSI	2.6	−11.6, 21.9	65	53	81	33	38
I-PRRS	0.9	−6.3, 11.6	68	67	86	40	32

Abbreviations: MIC: minimally important change; 95% CI: 95% confidence interval; PPV: positive predictive value; NPV: negative predictive value; % MIS: % misclassification; ACL-RSI: Anterior Cruciate Ligament – Return to Sports after Injury; I-PRRS: Injury Psychological Readiness to Return to Sport.

Table 4. Association between confidence about sports resumption and the MIC of ACL-RSI and I-PRRS scores.

		GRC score		Total
		More confidence	No change in confidence	
ACL-RSI	Change between 1 st and 2 nd measurement \geq 2.6	31	7	38
	Change between 1 st and 2 nd measurement $<$ 2.6	16	8	24
I-PRRS	Change between 1 st and 2 nd measurement \geq 0.9	32	5	37
	Change between 1 st and 2 nd measurement $<$ 0.9	15	10	25

Abbreviations: MIC: minimally important change; GRC: Global Rating of Change; ACL-RSI: Anterior Cruciate Ligament – Return to Sports after Injury; I-PRRS: Injury Psychological Readiness to Return to Sport.

−5.7 (SD = 13.2). MIC was 0.9 points, with a misclassification rate of 32% (Table 3).

The association between confidence in sports resumption and the MIC of ACL-RSI and I-PRRS scores is shown in Table 4. The relation of the MIC and SDC values in ACL-RSI and I-PRRS scores is visualised in Figure 1.

Discussion

This is the first study to investigate the responsiveness of the ACL-RSI and I-PRRS scales. Validity and reliability of the ACL-RSI and I-PRRS scales have been demonstrated in previous studies (Kvist et al., 2013; Slagters et al., 2017; Slagters et al., 2019). Unfortunately, the results of the study show that both questionnaires might be less suitable for detecting clinically important changes in individual patients over time or for evaluating the effectiveness of interventions on psychological readiness to resume sports participation.

In this study, the distribution and logistic regression-based methods are used to study the responsiveness of the two scores. Distribution-based methods rest on statistical characteristics of the sample distribution. These methods rather deal with smallest detectable change than any indication of the importance for the patient of the observed change, which is the ground for anchor-based methods (de Vet et al., 2007, 2010, 2006; Terluin et al., 2015). The outcome of the distribution-based analysis showed an SRM of 0.3 for the ACL-RSI scale and an SRM of 0.1 for the I-PRRS scale, both of which indicate low responsiveness. Of all available ACL-RSI and I-PRRS translations, only the Dutch and Swedish versions of the ACL-RSI scale and the Dutch version of the I-PRRS scale have determined the measurement error (Kvist et al., 2013; Slagters et al., 2017; Slagters et al., 2019).

Knowing the measurement error of the questionnaires and the MIC, one can determine whether the questionnaires can be used to monitor changes in individual patients. The SDC should be smaller than the MIC to distinguish important changes from measurement error in individual patients (Terwee et al., 2009). For both the ACL-RSI and the I-PRRS scale this is not the case; hence, it is not possible to distinguish MIC from measurement error in individual patients with either scale. Improvement larger than the SDC, which is 15 points for the ACL-RSI score and 11.6 points for the I-PRRS score, can be statistically significantly distinguished from the measurement error in individual patients. In this study only six patients based on the ACL-RSI and seven patients based on the I-PRRS score showed such an improvement (mean change ACL-RSI vs I-PRRS: 4.3 vs 1.3 points). Yet most patients (67.1%) reported having (much) more confidence in sport resumption after the same period. The positive predictive values of the ACL-RSI (82%) and I-PRRS (86%) for minimally important changes for improvement have no clinical significance for the individual patients because of the finding that the SDC is larger than MIC.

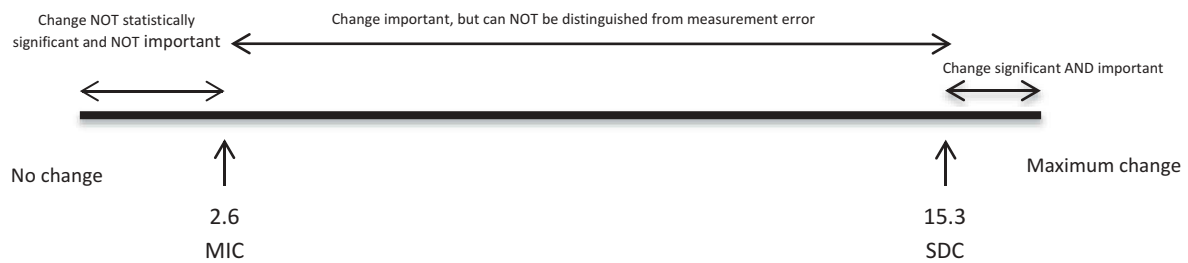
Practical implications

For practitioners, this study implicates that in individual patients the ACL-RSI and I-PRRS might be less suitable for detecting important changes or for evaluating the individual effectiveness of an intervention on psychological readiness to resume sports participation. Only changes larger than the SDC can be considered as statistically significant and clinically important in individual patients. Despite their insufficient responsiveness, the ACL-RSI and I-PRRS scales can be used as a screening instrument to identify patients who are at risk of not returning to sports, as both can be considered reliable and valid questionnaires (Slagters et al., 2017; Slagters et al., 2019). Moreover, both the ACL-RSI and I-PRRS seemed to show better responsiveness at the group level, given that the SDC group is, respectively, 1.5 and 1.1. Hence, the two scales can be used in cross-sectional studies to determine the effect of interventions at the group level. In recent years the ACL-RSI questionnaire has increasingly been used for this purpose (Ardern, Osterberg, et al., 2014; Langford, Webster, & Feller, 2009; Muller, Kruger-Franke, Schmidt, & Rosemeyer, 2015; Sadeqi et al., 2018; Webster et al., 2008).

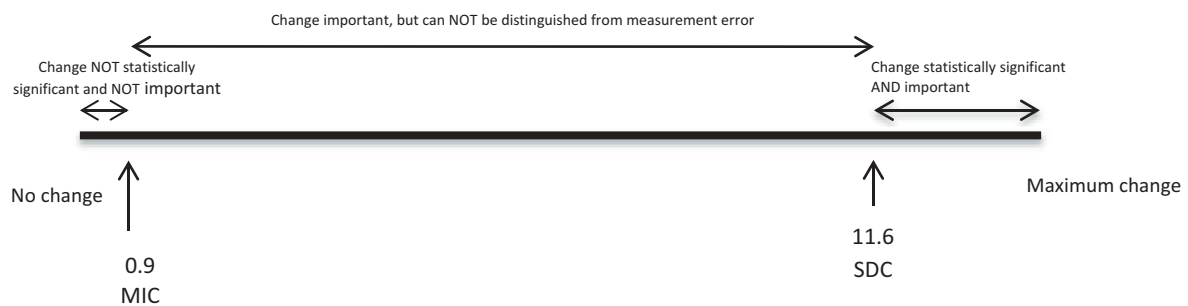
Strengths

This is the first study using the distribution- and anchor-based methods to examine the responsiveness of the ACL-RSI and I-PRRS scales in a large and representative group. The study population consisted of 70 participants, which complies with a minimum of 50 participants recommended for determining responsiveness (de Vet, Terwee, Mokkink, & Knol, 2011). Considering the gender distribution of the study population, the sample can be considered representative (61% male) (Ardern et al., 2011a). In this study, univariate logistic regression analyses were performed to estimate the MIC. Several methods have been proposed to determine the MIC in questionnaire scores but there is no consensus yet about the best method (Jaeschke, Singer, & Guyatt, 1989; Terluin et al., 2015;

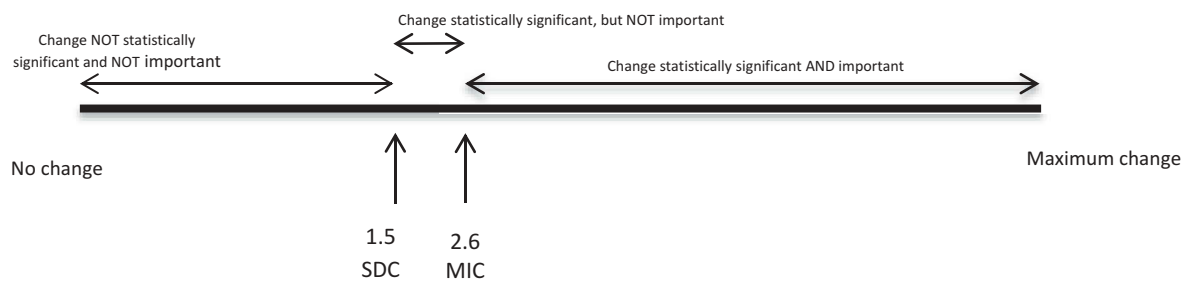
ACL-RSI – individual



I-PRRS – individual



ACL-RSI – group



I-PRRS – group

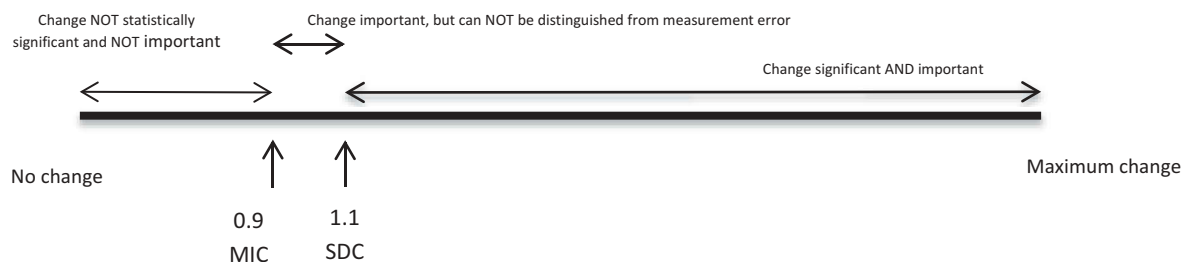


Figure 1. Minimal important change and smallest detectable change of the ACL-RSI and I-PRRS.

A visual relation of the MIC and SDC values of the ACL-RSI and I-PRRS scores in individuals and at group level. *Abbreviations:* ACL-RSI: anterior cruciate ligament – return to sports after injury; I-PRRS: injury psychological readiness to return to sport; MIC: minimal important change; SDC: smallest detectable change.

Terwee et al., 2007, 2009). Estimation of the MIC with this univariate logistic regression analysis seems more accurate than the ROC-based MIC (Terluin et al., 2015).

Limitations

There are several limitations that should be addressed. Few patients reported (much) less confidence; therefore,

a deterioration specific MIC value could not be calculated. Additionally, in this study, the GRC question was scored on a 5-point Likert scale. Clinically important changes would probably have been more discriminating had a 7- or 9-point scale been used (Kamper et al., 2009; Preston & Colman, 2000).

The GRC question, which is used as an external criterion to determine the importance of the change that patients experienced, may also be considered as a limitation. Although GRC questions are frequently used to calculate anchor-based MIC values, they have been criticized for its measurement performance and susceptibility to recall bias (de Vet et al., 2011; Grovle et al., 2014; Kamper et al., 2009). There is increasing evidence that people have difficulties to recall a previous health state and that their assessment is influenced by their current functional status. This effect exaggerates when measurement intervals become longer (Kamper et al., 2009). This may lead to either under- or overestimation in the GRC score (Grovle et al., 2014; Kamper et al., 2009; Ross, 1989). For the ACL-RSI and I-PRRS, the construct measured is “confidence in sports resumption”. Changes in psychological factors might be harder to recall when compared to, e.g., changes in physical factors like disability, physical functioning or limitations in activities. In this study 47 patients (67.1%) reported having (much) more confidence in sports resumption, while the mean change in scores was only small (ACL-RSI 4.3, I-PRRS 1.3 points).

Conclusion

In individual patients, the responsiveness of the ACL-RSI and I-PRRS scales seems to be insufficient to detect changes in confidence over time with regard to sports resumption after ACLR. Neither scale is able to distinguish minimally important changes from measurement error in individual patients. The scales are therefore less suitable for monitoring the effectiveness of individual interventions and to judge whether a patient has reached a change of importance. At the group level responsiveness seems sufficient, so the two scales can be used to investigate the effectiveness of an intervention at the group level. Furthermore, both scales can be used in cross-sectional research and in clinical practice as screening instruments to identify patients who are at risk of not returning to sports.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Table A1. Overview of the participants' main sports.

Main Sport	N (%)
Soccer	38 (54)
Korfbal	4 (6)
Volleyball	4 (6)
Field-hockey	3 (4)
Winter sports (skiing, snowboarding)	3 (4)
Handball	3 (4)
Tennis, squash, badminton	2 (3)
Athletics (running)	2 (3)
Other	11 (16)

Other: Fitness, cycling, basketball, kickboxing, darts, horseback riding, dancing, rugby, gymnastics